southerly winds and disturbed seas when cyclonic depressions passed eastward over the Newfoundland area; some peaceful days, with bright sunshine and gentle winds; a few hours of fog. A maximum temperature of 68° was recorded during a strong southerly wind. A minimum of 52° came with a gusty northwest wind, the water then being 51°. A change of wind, from northwest to southwest, brought a rise in temperature from 52° to 66°. To the ocean voyager who is meteorologically inclined, and who has the privilege of free access to the captain's quarters and the chart room, a trip across the North Atlantic at the present day is full of interest. He can read the weather reports sent in by other vessels, and during the ice season there is added interest in the regular broadcasts sent out by the United States Coast Guard cutter on ice patrol. If the *Jacques Cartier* is on cruise, he sees the excellent synopsis of general weather conditions which she broadcasts to all vessels. And he also has the opportunity to study the forecasts for the eastern United States and the adjacent waters broadcast from the Arlington station. How different were the conditions four decades ago, when the writer crossed the North Atlantic on a small sailing ship to the Azores and Madeira, and was absolutely without any word from vessel or from land for a month at a time! There is never monotony at sea. Even in the everlastingly hot and steaming Tropics there are constant changes in cloud forms and shadows, and in the wonderful beauties of the sunsets. Far more frequent and varied are the moods of the northern oceans, in the belt of the stormy westerlies, with their incessant alternations in temperature, in cloudiness, in wind—a never-ending interest to even the least observant ocean traveler.

The *President Monroe* anchored at the quarantine station in New York harbor at sunrise on a beautiful morning at the end of May. Slowly she steamed up the harbor to her pier. Her long voyage of nearly 30,000 miles, westward around the world, was happily ended. With renewed inspiration for his work; with enlarged views and a clearer understanding of the wonderful operation of nature's great atmospheric machinery, the writer's "wandering in search of weather" was brought to a successful close.

REFLECTIVITY OF DIFFERENT KINDS OF SURFACES

551.593

By HERBERT H. KIMBALL and IRVING F. HAND

[Weather Bureau, Washington, July 18, 1929]

The reflection measurements given in Table 3 of this paper were made by Mr. Hand from a Douglass O. H. plane, *The Dipper*, equipped with a Liberty motor, and piloted by Army air pilots from Bolling Field, D. C. Authority for the flights was obtained by the Secretary of Agriculture through the Secretary of War.

The photometer was designed especially for this purpose by Dr. L. F. Richardson, London, England, and is one of four constructed by Messrs. R. W. Munro with funds provided by the Bureau of the Meteorological Section, International Geodetic and Geophysical Union. A full description of the instrument and the method by which it has been standardized will be found in a paper by Richardson in Union Géodésique et Géophysique Internationale, Section de Météorologie. Troisième Assemblée Générale: Prague, 1927. Cambridge, 1928.

Briefly stated, the photometer has two windows—a small one of fixed diameter through which light is admitted from the sky, and a large one with an iris diaphragm that permits its diameter to be varied by the observer until equal illumination is obtained from the two sources under comparison. In the case under consideration the second source is reflection of skylight from the ground, and the proportion of light reflected is given by the ratio $\frac{A_s}{A_g}$, where A_s is the area of the window pointed toward the sky and A_g that of the window exposed to the ground. The area A_g is a function of a dial reading near the eyepiece of the photometer, which records the number of turns of a worm wheel that opens and closes the iris diaphragm.

Munro photometer No. 3, which was allotted to the United States Weather Bureau, was received in Washington late in 1927. Some preliminary readings were made from the ground during the winter of 1927–28, and are given in Table 2. Additional measurements made from a snow surface gave unsatisfactory results, since the instrument is not designed for measurements from highly reflecting surfaces. A neutral gray screen with a transmission of 0.49 ± 1 per cent has been obtained from the research laboratories, physics department, Eastman Kodak Co., for use in future measurements from snow and other highly reflecting surfaces.

Doctor Richardson has pointed out in his paper, above referred to, that the relation between the reading of the photometer dial and the diameter of the projection of the iris opening from the white photometer wedge, and which is measured by a scale etched on glass provided with the instrument for that purpose, may change from time to time. In Table 1 are given the original calibration by Richardson, a calibration made at the United States Bureau of Standards, and two calibrations made by the authors with a focusing flashlight. For a dial reading of 20 with the iris closing, calibrations No. 1 to No. 4 give reflections of 0.036, 0.026, 0.029, and 0.027, respectively, and for a dial reading of 25, also with the iris closing, reflections of 0.150, 0.074, 0.087, and 0.078, respectively.

From the above it is evident that the determinations of the relation between dial reading and iris opening are of the first importance, and one can not be sure that the relation does not change during a series of observations. In connection with the measurements here presented it has been assumed that the Bureau of Standards calibration (No. 2, Table 1) applies to the few readings made on January 3, 1928, and May 13, 1929; the calibration of May 20, 1929 (No. 3, Table 1) to the readings of May 14 and 21, and the calibration of June 5, 1929 (No. 4, Table 1), to the readings of June 3 and 24. Calibration readings have therefore been made to apply to series of observations that most closely precede and follow the date of the calibration.

The photometer was rigidly attached to the side of the cockpit of the airplane, so that when the plane was in its flying position the upper or sky window of the photometer received light from the zenith at normal incidence, and the lower or ground window, at normal incidence from the ground. No part of the plane could shade either the sky window or the ground window of the photometer.

The plane was usually flown at an air speed of from 95 to 110 miles per hour, which, when referred to the ground,

was augmented or decreased by the air movement, depending upon whether the flight was with or against the wind. The terrain over which the flights were made generally consisted of broken forest, interspersed with green grass or wheat fields, and ploughed fields of various textures, varying in color through white, yellow, red, and black. On account of the speed with which the plane was moving it was not always possible to tell from what particular spot on the ground a reflection measurement was made. In most cases, however, some peculiarity of color observed directly as the plane approached a selected point enabled the observer to pick it up through the photometer and made a photometer setting upon it.

Army air pilots are accustomed to fly not less than 1,000 feet above the ground. At this height it was not possible to determine the species of trees making up the forest areas. They were therefore designated as *light* or *dark* according to their appearance. It is probable that the forests designated *dark* consisted principally of pines and those designated *light* of mixed deciduous growth, including oak, maple, poplar, hickory, and many shrubs. During May and June, 1929, on account of well-distributed rains, the foliage was unusually verdant.

All the measurements were made with an overcast sky. The attempt was made to select days when the sky was covered with a uniform cloud sheet thick enough to exclude all direct rays of the sun. On account of the time that sometimes unavoidably elapsed between leaving the Weather Bureau observatory on the campus of the American University and the take-off at Bolling Field, about 10 miles from the university, on some days clouds were somewhat broken before observations commenced. In such cases the flight was in a direction that took the plane under the cloud sheet.

In Table 3, column 1 gives the relative brightness of the zenith and the surface described in column 5, or $\frac{A_s}{A_g}$, as determined from the dial reading on the photometer and the appropriate calibration given in Table 1. The zenith is the brightest point on a completely overcast sky. By data given by the authors in papers relating to sky brightness and daylight illumination [1] we have been led to adopt $\frac{1}{0.80}=1.25$ as the factor to apply to the values in column 1 to obtain the approximate reflection factor given in column (2). It is an approximate value only, for the reason that the relative brightness of different parts of the sky varies somewhat from day to day and from hour to hour. The factor given above represents mean conditions as derived from measurements made on many cloudy days.

That part of flight 4, Table 3, that lay over the ocean, was made on a day with rather smooth seas, and with haze that became dense 20 miles offshore. It would be of interest to repeat these measurements with a clearer sky and with both a rough and a smooth sea.

The observer's notes are given in full in connection with Table 3.

In Table 4 the reflection measurements are grouped—

(1) With respect to the surface over which they were made;

(2) With respect to the height above the surface over which they were made;

(3) With respect to the color of the screen through which the reading was made.

[1] 1921. Sky brightness and daylight illumination measurements. MONTHLY WEATHER REVIEW 49: 481 to 488. 1922. Daylight illumination on horizontal, vertical, and sloping surfaces. MONTHLY WEATHER REVIEW 50: 615–628.

The plane generally was flown very closely to heights above sea level agreed upon in advance by the observer and the pilot. Much of the country covered by the flights is but little above sea level. In flights that crossed the Catoctin or the Blue Ridge Mountains, an approximate correction for the height of the terrain above sea level was applied to the height of the plane to obtain the height of the latter above ground.

This summary does not show any relation between reflection measurements and the height above the surface at which they were made.

It was possible to obtain but few readings with the blue screen, as time was required to accustom the eye to the low light intensity it transmitted. This prevented settings on definite points.

The weakness of the green component in light reflected from a light-colored field is noteworthy, as is also the strength of the red and green components over grassy fields. Rivers also show a strong green component, but this may be due to the green foliage along the banks.

On account of the close similarity in the reflection from light and dark forest areas, readings obtained from them were combined under a common heading in Table 4.

It is hoped to repeat these measurements in the early winter when the summer foliage has disappeared.

TABLE 1.—*Iris diaphragm calibrations—Photometer Munro No. 3*

Reading of photometer dial	Diameter of projection of iris from white wedge on glass scale in connection with outside of large window—iris closing			
	No. 1	No. 2	No. 3	No. 4
	Centimeters	*Centimeters*	*Centimeters*	*Centimeters*
20	1.42	1.62	1.55	1.59
21	1.31	1.48	1.39	1.45
22	1.17	1.36	1.26	1.31
23	1.00	1.22	1.10	1.17
24	.87	1.06	1.01	1.05
25	.75	.96	.89	.92
26	.58	.80	.76	.79

No. 1. Calibration made by Doctor Richardson, Aug. 13, 1927.
No. 2. Bureau of Standards calibration, Dec. 15, 1928.
No. 3. Mean of readings made by Messrs. Kimball, Hand, and Tremearne, May 20, 1929.
No. 4. Mean of readings made by Messrs. Kimball and Hand, June 5, 1929.

TABLE 2.—*Preliminary readings with Munro photometer No. 3, January 3, 1928*

[Ratio, $\frac{A_s}{A_g}$ (unit = 0.001)]

Filter			Surface
None	Red	Green	
32	36	26	Black cinder driveway.
86	118	58	Yellow grass 1 foot high.
37	43	35	Green pine tree.
62	83	50	Chocolate-colored clay.
38	67	33	Convex surface of steel barrel; rusty.
47	53	58	Gray porch floor.
105	91	86	Conical surface of concrete-gravel pile.
299	221	155	Light brown granite.
155	139	105	Concrete sand.
68	68	68	Black automobile top.
93	99	102	Dirty 6-inch squares of concrete floor.
84	81	60	Bleached winter grass.
299	260	278	Clean white concrete.
		308	Very white lime concrete.
26	37	24	Level soft-coal pile.

Observations were also made on February 1, 1928, over clean white snow, but lacking a neutral glass filter to cut down the reflection, it is impossible to reduce the results.

TABLE 3.—*Test flight, No. 1. Left Bolling Field 3:15 p. m., May 13, 1929, returning to field 3:45 p. m.*

[Unit=0.001]

Ratio $\frac{A_r}{A_o}$	Reflection	Height	Filter	Position and notes
		Feet		
21	26	950	None	Over Potomac River near Alexandria.
70	87	1,000	do	Business section of Alexandria.
22	28	1,050	do	Washington, D. C., light fog intervening.
65	81	1,100	Red	Over Seventh and Pennsylvania Avenue SE., Washington, D. C.
74	92	1,050	Green	Suburbs, Washington, D. C.; much grass showing.
56	70	950	Red	Over Potomac River near navy yard; dropping rapidly.

The above readings are of little value. Practice was gained through actual use of instrument, but sky conditions were very poor. Moreover, in an attempt to get and remain below the cloud layer, the plane was continually banking so that no single reading may be relied upon to have been taken while the photometer was in a horizontal position.

TABLE 3.—*Flight No. 2. Took off from Bolling Field at 10:10 a. m., May 14, 1929, returned Bolling Field 12:15 p. m.; Captain Devery piloting*

[Unit=0.001]

Ratio $\frac{A_r}{A_o}$	Reflection	Height	Filter	Position and notes
		Feet		
53	66	1,000	Red	Dark trees; enroute to Baltimore.
52	65	1,000	do	Repeat reading.
68	85	1,000	do	Grass field.
34	42	1,000	do	Plowed land; yellow-black soil.
62	78	1,000	None	Yellow-black soil.
34	42	1,000	do	Plowed field; some green appearing.
65	81	1,000	Green	Orchard.
56	71	1,000	do	Do.
44	55	1,000	None	Village; much green grass showing.
38	48	1,000	do	Washington, D. C.
41	51	1,000	Green	Do.
46	58	1,000	Red	Do.
40	50	1,000	None	Trees.
42	52	1,000	None	Plowed field; reddish soil.
33	41	1,000	do	Village; mostly grass appearing.
34	42	1,000	do	Grass field.
41	51	1,000	Green	Trees.
29	36	1,000	do	Very dark trees.
27	34	1,000	Red	Do.
39	49	1,000	None	Over river near Bolling Field.
35	44	1,000	do	Fields and trees near Washington, D. C.
43	54	1,000	Green	Near Laurel, Md.; trees, fields, houses.
43	54	1,000	do	Forest near Laurel; excellent reading.
35	44	1,000	None	Forest.
28	35	1,000	Green	Very dark trees.
33	41	1,000	Red	Forest.
44	55	1,000	None	Chesapeake Bay; near shore.
53	66	1,000	do	Chesapeake Bay; near center.
52	65	1,000	Green	Do.
53	66	1,000	do	Do.
51	64	1,000	do	Chesapeake Bay; near shore.
46	58	1,000	None	Chesapeake Bay.
52	65	1,000	do	Factories in Baltimore; smoke below.
46	58	1,000	do	Factories in suburbs.
51	64	1,000	do	Residential section of Baltimore.
42	52	1,000	do	Blue-roofed suburb of Baltimore.
64	80	1,000	do	Chesapeake Bay.
52	65	1,000	Green	Do.
50	62	1,000	do	Do.
39	49	500	None	Do.
38	48	1,000	do	Oil tanks; Baltimore.
41	51	1,200	do	Railroad yards; Baltimore.
47	59	1,500	do	Heart of Baltimore.
41	51	2,000	do	Center of Baltimore.
59	74	1,900	do	Plowed yellow-black ground.
88	110	1,900	do	Plowed ground.
93	116	1,900	Red	Do.
91	114	1,900	None	Do.
82	102	1,900	Green	Trees.
79	99	1,900	None	Do.
93	116	1,900	Green	Do.
76	95	1,900	None	Forest.
74	92	1,900	Red	Do.
80	110	1,900	None	Do.

This flight was mostly over rather level land. Returning from Baltimore, the sun was out at times, but no readings were made when it was known that the sun was visible. Dropped to 1,900 feet from 2,000 on account of turbulence at the latter height.

TABLE 3.—*Flight No. 3. Took off from Bolling Field at 10:25 a. m., returning at noon, Lieutenant Stranathan piloting, May 21, 1929*

[Unit=0.001]

Ratio $\frac{A_r}{A_o}$	Reflection	Height	Filter	Position and notes
		Feet		
79	99	1,000	None	Potomac River near War College.
64	80	1,500	do	The Mall.
57	71	1,500	do	Near the Monument.
62	78	1,500	do	Over Weather Bureau.
56	70	1,500	do	Naval Observatory.
61	76	1,500	Green	Naval Observatory grounds.
58	72	1,000	do	American University campus.
62	78	1,500	do	Potomac River near Great Falls.
63	79	1,500	None	Fields.
32	40	1,500	do	Very dark woods.
46	58	1,500	do	Light woods.
49	61	1,500	Green	Fields; apparently pasture.
31	39	1,500	do	Dark woods.
34	42	1,500	do	Rolling meadows.
34	42	1,500	White	Mixed forest; mostly dark trees.
47	59	1,500	Green	Same forest; added filter.
65	81	1,500	do	Meadows.
69	86	1,500	Red	Red plowed ground.
54	68	1,500	do	Another red plowed patch; darker soil.
31	39	1,500	do	Grass field.
30	38	1,500	do	Woods.
25	31	1,500	Blue	Grass.
23	29	1,500	do	Woods.
22	28	1,500	do	Red plowed ground.
38	48	1,500	None	Dark woods.
71	89	1,500	do	Yellowish plowed ground.
95	119	1,500	do	Very white plowed ground.
28	35	1,500	do	Very dark woods on slope.
54	68	1,500	do	Red soil.
42	52	1,500	Green	Leesburg, with much green showing.
44	55	1,500	None	Leesburg.
34	42	1,500	Green	Orchard NNW. Leesburg on slope.
64	80	1,500	do	Oat field; lighter than grass.
61	76	1,500	None	Oat field.
64	80	1,500	Green	Red soil; plowed land.
63	79	1,500	Red	Reddish soil.
28	35	500	Green	Blue Ridge; very close to ground.
65	81	1,500	do	Green field west of Shenandoah River; flat.
20	25	1,000	do	Steep slope, Blue Ridge; very dark and broken.
19	24	1,000	None	Steep slope; forest on Blue Ridge.
51	64	1,500	Green	Quarry near Charles Town or Harpers Ferry.
49	61	1,500	None	Quarry; gray stone, probably limestone.
53	66	1,500	do	Woods west of Harpers Ferry; now climbing to get over Blue Ridge.
75	94	2,000	do	Woods near Harpers Ferry, W. Va.
73	91	2,000	Green	Do.
72	90	2,000	None	Junction of Shenandoah and Potomac Rivers.
79	99	2,000	Green	Potomac River just above Harpers Ferry.
28	35	2,000	None	Woods on very steep hillside; dark appearance. Now climbing and circling around Harpers Ferry. Very cold; difficult to write notes. Now in clouds; still colder with our speed of 120 miles per hour. Cloud feels like rain, but is merely the mist of cloud itself with high speed of plane. Again the effect of bumpiness is felt when the sun shows itself momentarily; many scuds.
59	74	2,500	do	Very dark woods on lesser range of hill, about 10 miles east of Harpers Ferry in Virginia.
61	76	2,500	Green	Woedy patch; darker than grass or oats.
69	86	2,500	do	Grassy pasture.
29	36	2,500	Red	Chocolate soil in Maryland. (Crossed river too rapidly to obtain reading over water.) This plowed land has every appearance of light milk chocolate; very striking as to color.
26	33	2,500	Green	Same chocolate soil.
27	34	2,500	None	Same chocolate soil; a large patch.
69	86	2,500	Red	Flying above the river lengthwise, using the red and green filters as well as taking a reading without them. River muddy. Now dropped to 2,000 feet, as it is too bumpy at 2,500 feet. Sun out, so had to wait until it clouded up again. Still cold.
74	92	2,500	Green	
77	96	2,500	None	
31	39	2,000	do	Great Falls. For about 40 miles no readings were made on account of the sun being out. Many scuds, but they passed too rapidly and were too small to get readings between clouds. Also lacked neutral screen to care for increased reflection. The whole trip was over rolling country, and in summarizing the measurements this has been considered in properly classifying as to height.

TABLE 3.—*Flight No. 4. Took off from Bolling Field in Douglass plane, "The Dipper," O. H. model, equipped with Liberty motor, at 10:30 a. m., June 3, 1929, landing at Bolling Field at 1:20 p. m.; Captain Devery piloting*

[Unit=0.001]

Ratio $\frac{A_r}{A_e}$	Reflection	Height	Filter	Position and notes
		Feet		
119	149	1,000	None	Plowed field; very white soil.
44	55	1,500	do	Forest.
46	58	1,500	Green	Do.
44	55	1,500	None	Village; name unknown.
72	90	2,500	do	Plowed whitish soil.
74	92	2,500	do	Do.
43	54	2,500	Green	Do.
30	38	3,000	do	Very dark forest.
87	109	3,000	None	Plowed land.
51	64	3,000	do	Forest.
49	61	4,000	do	Broken land; trees, plowed, houses, etc.
62	78	4,000	do	
65	81	4,000	Green	Chesapeake Bay. (These 5 readings were made while crossing a 10-mile section of the bay, "Red" reading 5 miles out from shore.)
54	68	4,000	Red	
61	76	4,000	None	
58	72	4,000	Green	
55	69	4,000	None	Woods; on an island.
57	71	4,000	Green	Do.
57	71	4,000	None	Chesapeake Bay. (Now crossing diagonally over narrower part of bay.)
57	71	4,000	Green	
42	52	4,000	None	Chesapeake Bay. Dark portion, weeds on water.
60	75	4,000	do	Chesapeake Bay. (Islands nearby.)
60	75	4,000	Green	Do.
75	94	3,500	None	Plowed land.
27	34	3,000	do	Forest.
37	46	3,000	Green	Fields; patchy brownish green.
38	48	3,000	do	Do.
38	48	3,000	None	Do.
53	66	2,500	do	Plowed land.
78	98	2,500	do	Very light-colored plowed land.
46	58	2,000	do	Plowed land of darker shade.
43	54	2,000	Green	Do.
42	52	2,000	do	Georgetown, Del.
44	55	2,000	None	Do.
55	69	2,000	Green	Grass; well-kept.
54	68	2,000	None	Do.
26	32	2,000	do	Very dark forest.
27	34	2,000	Green	Do.
34	42	2,000	None	Forest.
33	41	2,000	Green	Do.
22	28	2,000	None	Darkest forest I have yet seen over level ground.
23	29	2,000	Green	Same forest.
96	120	3,000	None	Plowed land.
87	109	3,000	Green	Do.
68	85	3,000	None	Do.
64	80	3,000	Green	Do.
102	128	3,000	None	Bright yellow sand on ocean shore.
70	88	3,000	Green	Do.
68	85	3,000	None	Ocean, near shore.
77	96	3,000	Green	Do.
68	85	2,500	None	2 miles out over ocean.[1]
72	90	2,500	Green	3 miles out.[1]
34	42	2,000	do	10 miles out.
42	52	2,000	None	Do.
35	44	2,000	Green	Do.
46	58	2,000	do	12 miles out.
42	52	2,000	None	Do.
31	39	2,000	Red	Do.
31	39	2,000	do	Repeat reading; same conditions.
29	36	2,000	Blue	15 miles out.
29	36	2,000	do	Repeat reading; same conditions.
26	33	2,000	None	About 20 miles out. Now in dense haze; rather extraordinary; toward the east the sky and water merged together, giving the appearance of an impenetrable bluish-gray wall. No horizon, either real or apparent. A few whitecaps showing.
28	35	2,000	do	Beyond the 20-mile limit.
29	36	2,000	Green	Last reading; had been traveling east to stay under bank of clouds. Immediately following this reading we turned around and started for home, but had too much interference from free sunshine to warrant further readings.

[1]Probably not truly indicative of average ocean conditions, as color is different from that several miles out, on account of plant growth and shallow water.

A peculiar line ran straight across the mouth of Delaware Bay from Cape Henlopen toward Cape May, probably due to a bar interfering with flow of water between the bay and the ocean. Captain Devery spoke about this line as being the most noteworthy feature he had observed during the flight. He also mentioned the bumpiness of the air, stating that several times the "joy stick" had been thrown out of his hand. The bumpiness was at times troublesome, due to impossibility of keeping one's eye near the eyepiece of the photometer.

The color of the sand at Cape Henlopen is remarkable and unusual. From a point several miles distant it gives the appearance of a muddy stream, but when close enough to see details one finds the color of the sand to be of a true golden-yellow hue.

The bumpiness was probably due to convection and the associated sea breeze. On the outward trip the level of greatest turbulence seemed to be at about 2,300 feet elevation; on the return trip it was somewhat higher. It was especially noticeable at the shore line of both the bay and the ocean.

We passed Fr.-Cu. over Chesapeake Bay, traveling at a high speed; in fact, there was a strong wind with easterly component during the entire trip at our flying levels.

Between Washington and the sea the trip was over exceedingly level land, so that no correction is necessary for variations in ground heights. Delaware, in particular, is very flat.

TABLE 3.—*Flight No. 5. Took off from Bolling Field in Douglass plane, "The Dipper," O. H. model, equipped with Liberty motor, at 10:50 a. m., June 24, landing at Bolling Field at noon; Lieutenant Merrick piloting*

[Unit=0.001]

Ratio $\frac{A_r}{A_e}$	Reflection	Height	Filter	Position and notes
		Feet		
94	118	1,000	None	Over Potomac River.
96	120	1,000	Green	Potomac River near Key Bridge.
100	125	1,500	do	Alexandria; much green showing.
80	100	1,500	None	Do.
51	64	1,500	do	Forest.
85	106	1,500	do	Now raining; over forest.
126	158	1,500	do	Village; hard rain.
72	90	1,500	Green	Fields; still raining.
61	76	1,500	None	Fields; raining.
74	92	1,500	do	Mixed fields, grass, and earth; light rain.
80	100	1,500	do	Village; very light rain.
58	72	2,000	do	Washington, D. C.
81	101	2,000	do	Washington, D. C., hard rain.
96	120	2,000	do	Washington, D. C.; hard rain; plane 30° from horizontal; banking to get out of rain.
65	81	1,500	do	Washington, D. C.; light rain.
63	79	1,500	Green	Country fields.
27	34	1,500	Red	Laurel, Md.
57	71	1,500	Green	Fields.
62	78	1,500	do	Do.
68	85	1,500	None	Forest.
47	59	1,500	do	Do.
36	45	1,500	Red	Fields.
80	100	1,500	do	Fields, but hard rain.
78	98	1,500	None	Fields.
59	74	1,000	do	Woods.
78	98	1,000	do	Fields; raining.
72	90	1,000	do	Woods; raining.
80	100	1,500	Green	Grass; raining; trying to get above rain.
80	100	1,500	None	Grass; raining. Very bumpy now; sun coming out; 10-minute flight to get under clouds again.
37	46	2,000	Red	Washington, D. C.
42	52	2,000	Green	Do.
74	92	2,000	do	Potomac River; crossing to Virginia.
85	106	2,000	Red	Muddy Potomac River.
80	100	2,000	None	Washington, D. C.
91	114	2,000	do	Washington, D. C.; in cloud; no visibility.
140	175	2,000	do	Same, with denser cloud.
75	94	2,000	Green	Washington, D. C.; in thin cloud.
56	70	2,000	Red	In thin cloud, over D. C.
64	80	2,000	None	Over Mall; dense cloud overhead but no rain.
46	58	2,000	Red	Railroad yards; black underneath.
420	525	2,000	None	River; very hard rain; almost no visibility.
350	438	2,000	Green	Do.
73	91	2,000	None	Mall; light rain.
44	55	2,000	Red	Washington, D. C.; stopped raining.
42	52	2,000	Green	Washington, D. C.
49	61	2,000	None	Washington, D. C. As sun is now coming out, we headed for the field.

It is thought that the large increase in reflection is due to darkening of the sky window of the photometer by rain and to change in light distribution while in heavy rain and in clouds. However, with an air speed of 100 to 130 miles per hour the effect of water on the sky window could have been temporary only, due to rapid evaporation following cessation of rain.

The air was exceedingly smooth while in the clouds, but rather bumpy when the sun was visible.

The warm layer of air near the surface of the ground was the shallowest I have ever noted. Apparently it was overrun by a much cooler current at an elevation of from 100 to 150 feet, while ordinarily one expects a gradual cooling with increase in height.

TABLE 4.—*Summary of reflection measurements*

[Unit=0.001L]

	Screen															
	White							Red			Green					Blue
Altitude (feet)	1,000	1,500	2,000	2,500	3,000	3,500	4,000	1,000	1,500	2,000	1,000	1,500	2,000	2,500	3,000	1,500
Grassy fields:																
Ratio $\frac{A_s}{A_g}$	40	60	54					78	31		66	55	62		38	25
Reflection	50	75	68					98	39		82	69	78		48	31
Dark plowed fields:																
Ratio $\frac{A_s}{A_g}$	57		36	53				41	62	29		64	34			22
Reflection	71		45	66				51	78	36		80	42			28
Light plowed fields:																
Ratio $\frac{A_s}{A_g}$	98			75	82	75	87							43	76	
Reflection	122			94	101	94	109							54	95	
Sand on seashore:																
Ratio $\frac{A_s}{A_g}$					102										70	
Reflection					128										88	
Mostly trees:																
Ratio $\frac{A_s}{A_g}$	47										55					
Reflection	59										69					
Forest areas:																
Ratio $\frac{A_s}{A_g}$	37	44	54		39		55	52	30	89	32	55	27	31	57	23
Reflection	46½	55	68		49		69	65	38	111	40	69	34	39	71	29
Quarry (light gray stone):																
Ratio $\frac{A_s}{A_g}$	49										51					
Reflection	61										64					
City areas:																
Ratio $\frac{A_s}{A_g}$	59	58	50					60			74					
Reflection	74	72	62					75			92					
Villages:																
Ratio $\frac{A_s}{A_g}$		44	44										42			
Reflection		55	55										52			
Mixed country and towns:																
Ratio $\frac{A_s}{A_g}$	46						49	30			42					
Reflection	58						61	38			52					
Rivers:																
Ratio $\frac{A_s}{A_g}$	73	67	54					56		69	96	79	74			
Reflection	91	84	68					70		86	120	99	92			

	Screen													
	White					Red				Green				Blue
Altitude (feet)	500	1,000	2,000	,000	4,000	1,000	2,000	3,000	4,000	500	1,000	2,000	4,000	2,000
Chesapeake Bay (near shore):														
Ratio $\frac{A_s}{A_g}$	66	61								64	62			
Reflection	82	76								80	78			
Chesapeake Bay (near center):														
Ratio $\frac{A_s}{A_g}$		63			56				54		62		60	
Reflection		79			70				68		78		75	
Ocean (near shore):														
Ratio $\frac{A_s}{A_g}$					68								74	
Reflection					85								92	
Ocean (10–12 miles from shore):														
Ratio $\frac{A_s}{A_g}$			42				31					38		29
Reflection			52				39					48		36
Ocean (15–20 miles from shore):														
Ratio $\frac{A_s}{A_g}$			27									29		29
Reflection			34									36		36